ABSTRACT

Glacial lakes formed by glacier retreats due to global warming threaten living beings and costly infrastructures in the Himalayan region by creating GLOF. In this thesis, we envisage determining glacial lake hazards collectively under the detailed study of lake morphodynamics, future zone of glacial lake formation, and GLOF probability of existing lakes. We proposed methods: overlay analysis, cumulative frequency, feature importance, logistic regression, object-based classification, average lake size change rate, and Analytical Hierarchy Process to achieve our objectives. Moreover, we used various raster datasets such as satellite imagery, DEMs, landslide probability, avalanches probability, ice thickness, glacier surface velocity, normalized elevation, land surface temperature, precipitation and temperature, and vectors: earthquake location, glacier boundary and lake boundary. Here, we focused on supraglacial and proglacial lakes in separate studies because of their diverse genesis and places of formation concerning the mother glacier.

A glacial lake geodatabase was created by taking mother glacier, topographic, lake, climatic and triggering factors for the Himalayan region. Moreover, proglacial lake morphodynamics was studied, taking 4198 proglacial lakes (>0.01km^2) out of 9676 lakes in the Himalayas from 1990-2019. Sub-regionally, Sikkim, Everest, Bhutan and Langtang regions contain most lakes with higher lake size increases. We found an average increase rate in lake size of 26% and lake number of 82%. Besides, supraglacial lake morphodynamics was studied temporarily for the Himalayas, taking 2072 glaciers. The supraglacial lake size and number are continuously increasing since 1990 in the Himalayas. The static lakes are generally concentrated at the lower part of the ablation area with fast increase in surface area. Besides, logistic regression tools establish the zone of future lake formation in the Himalaya taking 14 controlling parameters. However, we noted that more lakes are forming in the central Himalaya than the eastern and western Himalaya. Furthermore, GLOF probability mapping was done by taking lake, dam, mother glacier and local triggering factors in the Himalayas. Object-based classification and AHP methods were used for doing this. Subsequently, we got 60, 164, and 3974 glacial lakes with higher, medium, and lower probability of lake outbursts in the Himalayas, respectively, and these are typically concentrated in central Himalaya.

Keywords: Himalaya, Glacial lake, GLOF, AHP, logistic regression, object based classification